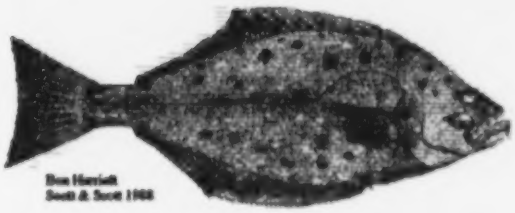
Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Maritimes Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/027

# PROJECTIONS OF THE ATLANTIC HALIBUT POPULATION ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS (NAFO Divisions 3NOPs4VWX5Zc)



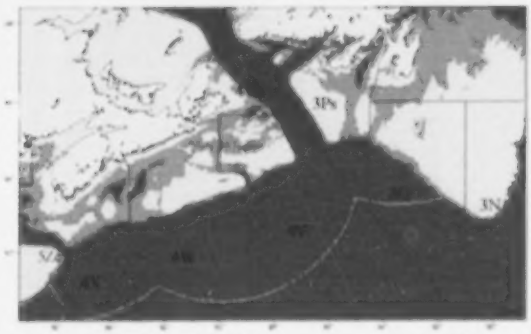


*Figure 1. Atlantic halibut management unit 3NOPs4VWX5Zc.*

## Context

*Atlantic halibut (Hippoglossus hippoglossus) is the largest of the flatfishes and ranges widely in the waters off Canada's East Coast. The management unit (3NOPs4VWX5Zc) is based largely on tagging results that indicated Atlantic halibut move extensively throughout the Canadian North Atlantic. The Atlantic halibut fishery was unregulated until a total allowable catch (TAC) was implemented in 1988 and a legal size limit (≥81 cm) was set in 1994. While the DFO research vessel survey provides information on incoming recruitment, estimates of exploitable biomass (≥81 cm) are considered unreliable. An industry / DFO longline halibut survey on the Scotian Shelf and southern Grand Banks (3NOPs4VWX5Zc) was initiated in 1998 to better estimate adult biomass. A commercial index is conducted in conjunction with the halibut survey. The halibut survey and commercial index generate indices of halibut abundance for the Scotian Shelf and southern Grand Banks, as well as estimates of population size structure.*

*The last assessment of Atlantic halibut was conducted in November 2010 (DFO 2011). This assessment used a new assessment framework and produced estimates of spawning stock biomass and fishing mortality. The current analysis was requested to evaluate the consequences of different harvest levels and the risk to the productivity of the stock.*

*This Science Advisory Report is from the Maritimes regional science advisory meeting of November 22, 2012 to review the Assessment of 4X5Y Haddock and Projections for 3NOPs4VWX+5Zc Atlantic Halibut. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.*



Canada

## SUMMARY


- Based on model projections, 3NOPs4VWX5Zc Atlantic halibut is in a productive period due to high recruitment. The spawning stock biomass is expected to increase, and there is little risk in harming the productivity of the stock at harvest levels < 4,000 t.
- The probability of exceeding the target removal reference, Fref=0.2, is low (<0.1%) at current catch levels, and the probability decreases as the population grows. Projections to 2014 show that the probability of exceeding the limit removal reference, Flim=0.36, is also low (<1%) at a catch of 3,400 t per year.
- A catch of 1,850 t in 2012 (2012/2013 total allowable catch, TAC) is expected to result in a fishing mortality (F) of 0.15 and a 9.5% percent increase in biomass in 2013. A catch of 2,127.5 in 2012 (15% increase to the TAC) is expected to result in an F of 0.17 and a 7% percent increase in biomass.
- In a comparison of biomass at maximum sustainable yield (Bmsy) and fishing mortality at maximum sustainable yield (Fmsy) generated using a Beverton-Holt stock-recruit model versus a Ricker model, Bmsy and Fmsy differed by a factor of 2, demonstrating the sensitivity of these reference points to model assumptions.
- The 2011 population spawning stock biomass is projected to be above Bmsy regardless of which stock-recruit model is used.
- Several sources of uncertainty have not been incorporated into the projections, for example, uncertainty in natural mortality, selectivity to the fishing gear, and the stock-recruit parameters.


## INTRODUCTION

The Department of Fisheries and Oceans' policy on fisheries management is to use the precautionary approach, in which biological reference points are to be used in the decision making process (DFO 2009). Reference points (Bmsy, Fmsy) were presented at the last assessment of the Scotian Shelf southern Grand Banks (Divs. 3NOPs4VWX5Zc) Atlantic halibut stock (Trzcinski et al. 2011) and have subsequently adopted. These were produced using a Ricker stock-recruit model. These references were contrasted with a Beverton-Holt model to examine the sensitivity of the reference points to model selection.

## Rationale for Analysis

Advice has been requested by Fisheries and Aquaculture Management (FAM) on the stock status of 3NOPs4VWX5Zc Atlantic halibut. Specifically, FAM has asked for an evaluation of:

- For a range of total catch values in 2012/13 and 2013/14, estimate the risk that fishing mortality rate (F) would exceed F=0.2 and F=0.36 in each year. Include a table showing the 2012/13 and 2013/14 catches corresponding to low (25%), neutral (50%) and high (75%) probability that the F would exceed F=0.2 and F=0.36.
- For a range of total catch values in 2012/13 and 2013/14, estimate the risk that the spawning stock biomass (SSB) would decline by 10%, remain stable (a change in SSB <10%), or increase by 10% from the previous year.

- Estimate the risk that the fishing mortality would exceed F=0.2 and F=0.36 in 2012/13, and the risk that biomass would decline by 10%, remain stable or increase by 10% at a catch of 2127.5 mt or 1572.5 mt (plus or minus 15% of the 2011/12 TAC).

## ANALYSIS

Fmsy and Bmsy generated from the Ricker curve are shown in Figure 2. For comparison, Fmsy and Bmsy generated using a Beverton-Holt stock-recruit model are also provided. This shows that Bmsy and Fmsy differed by a factor of 2, demonstrating the sensitivity of these reference points to model assumptions for this stock.

The 2011 population spawning stock biomass is projected to be above Bmsy regardless of which stock-recruit model is used.

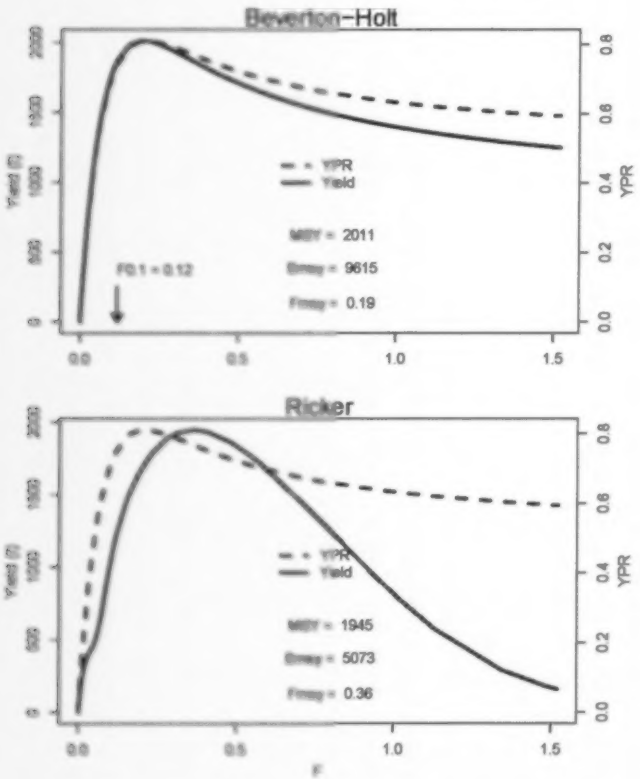



*Figure 2. Atlantic halibut yield estimated from Beverton-Holt (black line) and Ricker (red line) stock recruitment models. The curves show $F_{msy}$ at 0.19 for the Beverton-Holt and 0.36 for the Ricker models. Yield per recruit (dashed line) is plotted for comparison.*

Projections are calculated by calendar year, but the fishery is managed from April 1 to March 31. For a range of catches in 2012, 2013, and 2014, the risk of exceeding an F of 0.2 and 0.36 are provided in Tables 1 and 2.

Potential references, limit reference point (LRP), upper stock reference (USR), and Fmsy, were presented in Trzcinski et al. (2011). Fmsy is taken to be a limit removal reference (Flim).

A target removal reference (Fref) of 0.2 was chosen based on examination of the data in Figure 3, and discussions between industry and management.

*Table 1. The probability of exceeding $F_{ref}$=0.2 for a given catch (t).*

| | Year | | |
|---|---|---|---|
| Catch | 2012 | 2013 | 2014 |
| <2200 | 0 | 0 | 0 |
| 2300 | 0.011 | 0 | 0 |
| 2400 | 0.160 | 0.022 | 0.003 |
| 2500 | 0.702 | 0.355 | 0.132 |
| 2600 | 0.970 | 0.887 | 0.719 |
| 2700 | 0.999 | 0.996 | 0.982 |
| >2800 | 0.999 | 0.999 | 0.999 |

*Table 2. The probability of exceeding $F_{lim}$=0.36 for a given catch (t).*

| | Year | | |
|---|---|---|---|
| Catch | 2012 | 2013 | 2014 |
| <3300 | 0 | 0 | 0 |
| 3400 | 0 | 0 | 0.009 |
| 3500 | 0 | 0 | 0.111 |
| 3600 | 0 | 0.017 | 0.497 |
| 3700 | 0 | 0.133 | 0.877 |
| 3800 | 0.001 | 0.486 | 0.988 |
| 3900 | 0.020 | 0.842 | 0.998 |
| 4000 | 0.132 | 0.975 | 0.999 |
| 4100 | 0.398 | 0.997 | 0.999 |
| 4200 | 0.747 | 0.999 | 0.999 |
| 4300 | 0.936 | 0.999 | 0.999 |
| 4400 | 0.992 | 0.999 | 0.999 |
| >4500 | 0.999 | 0.999 | 0.999 |

The probability of exceeding Fref=0.2 is low (<0.1%) at current catch levels, and the probability decreases as the population grows. Projections to 2014 show that the probability of exceeding Flim=0.36 is also low (<1%) at a catch of 3,400 t per year.

Similarly, the catch that corresponds to a low, neutral and high probability that fishing mortality will exceed Fref and Flim was calculated (Tables 3a and b).

*Table 3a. Catches corresponding to low (25%), neutral (50%) and high (75%) probability that fishing mortality (F) would exceed $F_{ref}$=0.2.*

| | Quantile | | |
|---|---|---|---|
| Year | 0.25 | 0.5 | 0.75 |
| 2012 | 2417 | 2463 | 2518 |
| 2013 | 2468 | 2527 | 2574 |
| 2014 | 2520 | 2563 | 2612 |

*Table 3b. Catches corresponding to low (25%), neutral (50%) and high (75%) probability that fishing mortality (F) would exceed $F_{ref}$=0.36.*

| | Quantile | | |
|---|---|---|---|
| Year | 0.25 | 0.5 | 0.75 |
| 2012 | 4044 | 4129 | 4202 |
| 2013 | 3733 | 3804 | 3874 |
| 2014 | 3536 | 3601 | 3667 |

A catch of 1,850 t in 2012 (2012/2013 TAC) is expected to result in an F of 0.15 and a 9.5% percent increase in biomass in 2013. A catch of 2,127.5 in 2012 (15% increase to the TAC) is expected to result in an F of 0.17 and a 7% percent increase in biomass.

The history of the stock in terms of spawning stock biomass (SSB) and fishing mortality is shown in Figure 3. The upper stock reference and the limit reference point (USR = 3,920 t, LRP = 1,960 t) were taken from Trzcinski et al. (2011) and are close to those recalculated here using the Ricker stock-recruit model (4,058 t and 2,029 t respectively). Projections at $F_{ref}$ = 0.20 and $F_{lim}$ = 0.36 are also shown in Figure 3. The population is expected to remain in the healthy zone over the next 3 years at any harvest level under 4,000 t, regardless of the sensitivity of the model assumptions to the reference points.

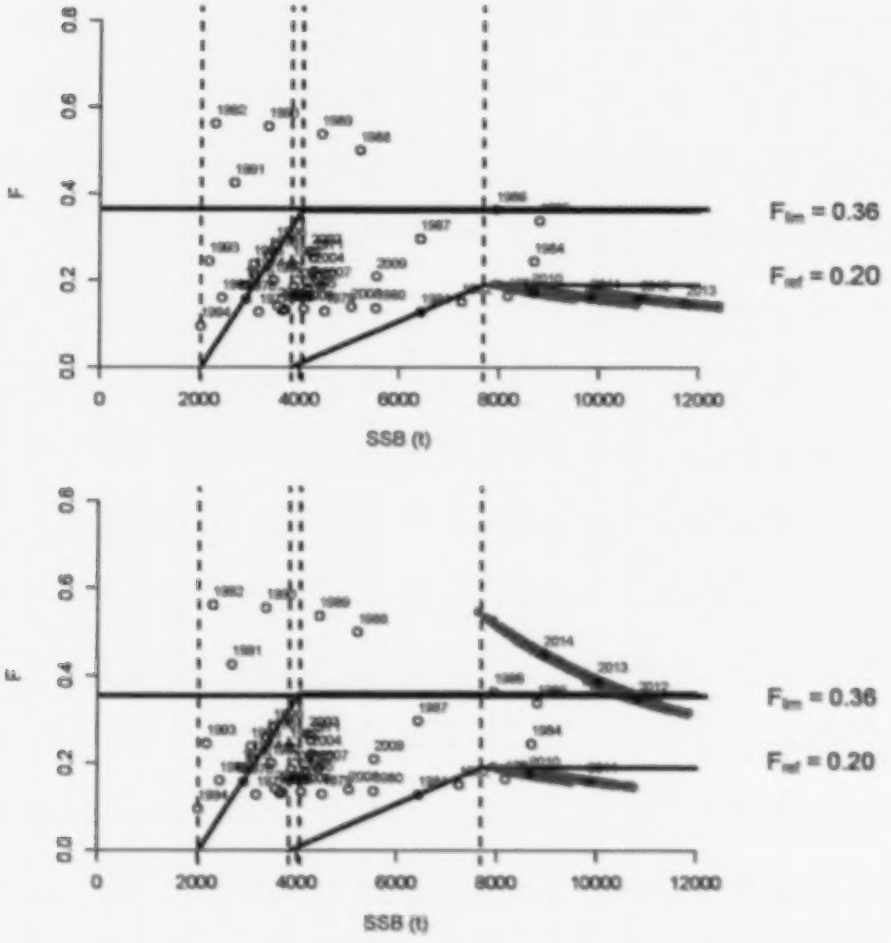



*Figure 3. Harvest control rule for halibut using Beverton-Holt (black) and Ricker (red) model results. The vertical lines mark the boundaries between critical, cautious, and healthy domains. The history of the stock is shown as labeled points. The stock was projected ahead for 5 years assuming removals of 1,700t and 1,850t for 2010 and 2011 and 2,000 t per year for 2012-2014 (upper), 4,000 t per year for 2012-2014 (lower). The grey region represents the uncertainty in the projected F and SSB.*

## Sources of Uncertainty

Several sources of uncertainty have not been incorporated into the projections, for example, uncertainty in natural mortality, selectivity to the fishing gear, and the stock-recruit parameters.

## CONCLUSIONS AND ADVICE

Based on model projections, 3NOPs4VWX5Zc Atlantic halibut is in a productive period due to high recruitment. The spawning stock biomass is expected to increase, and there is little risk in harming the productivity of the stock at harvest levels <4,000 t.

## OTHER CONSIDERATIONS

Information used for projections come from three primary sources that are monitored annually: the DFO research vessel survey, the halibut survey, and the catch information.

## SOURCES OF INFORMATION

This Science Advisory Report is from the Maritimes regional science advisory meeting of November 22, 2011 to review the Assessment of 4X5Y Haddock and Projections for 3NOPs4VWX+5Zc Atlantic Halibut. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

DFO, 2009. A Fishery Decision-Making Framework Incorporating the Precautionary Approach. *http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm* (Accessed May 1, 2012)

DFO, 2011. Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/001.

Trzcinski, M.K., S.L. Armsworthy, S. Wilson, R.K. Mohn, and S.E. Campana. 2011. A Framework for the Assessment of the Scotian Shelf and Southern Grand Banks Atlantic Halibut Stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/002.

## FOR MORE INFORMATION

Contact: Kurtis Trzcinski
Population Ecology Division
Bedford Institute of Oceanography
P.O. Box 1006 Dartmouth
Nova Scotia
B2Y 4A2
Tel: (902) 426-9781
Fax: (902) 426-1506
E-Mail: Kurtis.Trzcinski@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice,
Maritimes Region
Department of Fisheries and Oceans
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Phone number: 902-426-7070
Fax: 902-426-5435
e-mail address: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)
© Her Majesty the Queen in Right of Canada, 2012

*La version française est disponible à l'adresse ci-dessus.*

## CORRECT CITATION FOR THIS PUBLICATION

DFO. 2012. Projections of the Atlantic Halibut Population on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/027.